

Guidelines for Use of Service-Level Flexibility Parameters

1 Background and Purpose

Experience with the baseline NCCDS indicated a need for a service-level flexibility capability. This capability can greatly reduce the need for customer interaction with the NCC scheduling operator when minor modifications are needed to allow schedule requests to be successfully scheduled.

The NCCDS 1998 service-level flexibility capability is based on the five parameters specified in Table 7-2a of the MOC ICD. Each of these parameters was created in response to specific known customer needs. However, the original specification of these parameters placed very little restriction on the use of combinations of these parameters and allowed for extremely complex service-level interrelationships that do not correspond to known customer needs.

The purpose of this paper is to specify guidelines for the use of the service-level flexibility parameters. These guidelines are intended to clarify how the NCCDS will apply the service-level flexibility parameters, and to promote effective use of these parameters.

2 Overview of The Service-Level Flexibility Parameters

2.1 Service-Level Flexibility Parameters

Table 7-2a of the MOC ICD specifies five parameters:

- SBSN
- CSN
- STPT
- STMT
- MIND

2.2 SBSN

When neither SBSN (Service Bounded by Service Number) nor CSN (Coupled Service Number) is used, a service's nominal start time is relative to event start time. The SBSN parameter allows the customer to specify that the start and end times of a service are to be bounded by the start and end times of a referenced service. When the customer specifies SBSN, the NCCDS may slide the bounded service anywhere within the bounding service in an attempt to find a time when it can be scheduled. SBSN cannot be specified when CSN, STPT, or STMT are specified. For SBSN to provide significant benefit, two conditions should ordinarily exist:

- The two services should require different primary TDRS resources (e.g., an SA antenna and an MA antenna).

- When SBSN is specified, the nominal service start time parameter is not applicable. Therefore the customer should be willing to accept placement of the bounded service anywhere within the bounding service.

NOTE

The algorithm used by the NCCDS tends to place the bounded service as early as possible within the bounding service.

2.3 CSN

When neither SBSN nor CSN is used, a service's nominal start time is relative to event start time. CSN allows the customer to specify that the nominal start time of a service is relative to the start time of a referenced service. This preserves the relationship between the two services when the NCCDS slides the referenced service in an attempt to find a time when it can be scheduled. CSN cannot be specified when SBSN is specified. For CSN to provide significant benefit, two conditions should ordinarily exist:

- The customer should specify some form of service-level flexibility for the referenced service.
- The two services should either require the same primary TDRS resource or have a tightly coupled operational relationship (e.g., a return service coherent with a forward service).

2.4 STPT

STPT (Service Start Time Plus Tolerance) allows the customer to specify that a service's actual start time may be later than its nominal start time. When the customer specifies STPT, the NCCDS may slide the service in an attempt to find a time when it can be scheduled. STPT may be specified either with or without CSN also being specified. STPT cannot be specified when SBSN is specified. For STPT to provide significant benefit, two conditions should ordinarily exist:

- If CSN is specified, the service should require a different primary TDRS resource than the service to which it is coupled.
- The customer should be willing to accept any service start time from the nominal time to the nominal time plus the full value of STPT. However, the NCCDS is required to place the service as close as possible to the nominal start time.

2.5 STMT

STMT (Service Start Time Minus Tolerance) allows the customer to specify that a service's actual start time may be earlier than its nominal start time. When the customer specifies STMT, the NCCDS may slide the service in an attempt to find a time when it can be scheduled. STMT may be specified either with or without CSN also being specified. STMT cannot be specified when SBSN is specified. For STMT to provide significant benefit, two conditions should ordinarily exist:

- If CSN is specified, the service should require a different primary TDRS resource than the service to which it is coupled.

- The customer should be willing to accept any service start time from the nominal time to the nominal time minus the full value of STMT. However, the NCCDS is required to place the service as close as possible to the nominal start time.

2.6 MIND

MIND (Minimum Service Duration) allows the customer to specify that a service may be scheduled with a duration less than its specified nominal duration. When the customer specifies MIND, the NCCDS may reduce the duration to fit the service within the available resources. For this to be useful, the customer's operations must be adaptable to a range of service durations. However, the NCCDS is required to schedule the service with a duration as close as possible to the nominal duration.

3 General Rules and Limitations

3.1 Nominal Values

The service-level flexibility parameters are intended to be used to resolve resource allocation conflicts. The NCCDS is not required to use these parameters to rearrange services to achieve compliance with the SN scheduling ground rules. In other words, the event specified by the schedule request should be in compliance with the SN scheduling ground rules when the nominal service start time and service duration values are used.

NOTE

When SBSN is specified for a service, the nominal service start time parameter is not applicable for that service and the NCCDS must always determine service start time.

3.2 Specified Values for Service-Level Flexibility Parameters

3.2.1 Invalid Values

The NCCDS may reject a schedule request if independent use of the full specified value of a service-level flexibility parameter would create an invalid event. Examples include:

- MIND specified with a value less than one minute.
- STPT specified with a value that would cause the total duration of an event to exceed 24 hours.

3.2.2 Flexibility Combinations

The customer is not required to ensure that all possible combinations of all possible values of all flexibility parameters will yield a valid event. The NCCDS must limit its application of the flexibility parameters such that an event that is initially valid remains valid. In particular, there can be no time within an event during which no service is active. In conjunction with its use of the specified service-level flexibility parameters, the NCCDS may extend the duration of any service in order to avoid the creation of such a gap.

3.3 Event Structure

3.3.1 Service Start Times

Service start times may be specified relative to event start time, may be specified relative to the start time of another service through use of CSN, or may be implicitly bounded by another service through use of SBSN. Service start time flexibility may be specified by use of STPT, STMT, or SBSN.

- a. In all cases, a schedule request must include at least one service whose start time is specified relative to event start time, i.e., neither CSN or SBSN is specified.
- b. If a schedule request does not specify event start time flexibility, service start time flexibility may be specified for any of the services in the schedule request.
- c. If a schedule request specifies event start time flexibility, it must also specify that at least one service is anchored to the event start time. However, service start time flexibility may be specified for any of the other services in the schedule request. For a service to have its service start time anchored to the event start time, the following conditions must be true:
 - SBSN is not specified.
 - CSN is not specified.
 - STPT is not specified.
 - STMT is not specified.
 - Nominal service start time is specified as 00 hours 00 minutes 00 seconds.

3.3.2 Event Start Time

In a scheduled event, no service can begin earlier than event start time and at least one service must begin at event start time. The NCCDS will ensure this as follows:

- a. If a schedule request does not specify event start time flexibility, the NCCDS will apply any specified service-level flexibility as needed. The NCCDS will then use the earliest actual scheduled service start time as the actual scheduled event start time.
- b. If a schedule request specifies event start time flexibility, the NCCDS will limit use of service-level flexibility parameters so that no service's start time becomes earlier than the event start time.

3.3.3 Event Start Time Flexibility

Event start time flexibility is primarily used to resolve resource conflicts for services with no service start time flexibility. When event start time flexibility is applied, the internal event structure is not changed. There is no change to the relative service start times, and the actual service start times of all services are initially incremented or decremented by the amount of event start time plus or minus tolerance that was applied. Subsequently, service start times of services with service start time flexibility may then be adjusted as needed to resolve resource conflicts applicable to these services.

3.3.4 Event Duration

No event's duration can exceed 24 hours. When a combination of service-level flexibility parameters is specified, the NCCDS must limit their use so that event duration does not exceed 24 hours.

3.3.5 Circular Relationships

No service can have its start time specified, either directly or indirectly, relative to itself. Prohibited circular relationships include, but are not limited to:

- Using CSN to couple a service to itself.
- Using SBSN to bound a service by itself.
- Using CSN to couple a service to a second service that is coupled to the first service.

3.4 Precedence

When use of flexibility is necessary to resolve resource allocation conflicts, the NCCDS is required to apply flexibility parameters in the following precedence order:

- a. Select alternate TDRSS resources (e.g., SA antenna).
- b. Apply event start time flexibility and/or apply service start time flexibility.

When event start time flexibility is specified, the NCCDS must place the event start time as close as possible to the nominal event start time. When service start time flexibility is specified through use of STPT or STMT, the NCCDS must place the service start time as close as possible to the nominal service start time. When service start time flexibility is specified through use of SBSN, the NCCDS may select any valid service start time that will allow the service to remain bounded by the referenced service.

- c. Apply MIND.

The NCCDS must schedule services with durations as close as possible to the nominal durations.

NOTE

When SBSN is specified for a service, the NCCDS must always determine service start time. A preliminary determination of a valid service start time may be needed before TDRSS resources can be selected. However, all start time flexibility options must be exhausted before MIND can be applied to any service.

4 Interrelationships Required by SN Scheduling Ground Rules

4.1 Introduction

Specific limitations on service-level flexibility apply when the SN scheduling ground rules specify particular interrelationships among two or more services. There are four such instances. These fall into two groups:

- a. Interrelationships based on primary and secondary services.
 - 1. One-way tracking.
 - 2. Coherent pairs.
 - 3. Two-way tracking.
- b. End-to-end test.

4.2 Interrelationships Based on Primary and Secondary Services

4.2.1 General

The following guidelines serve as a model for how the service-level flexibility parameters should be used for one-way tracking, coherent pairs, and two-way tracking. As implied by the SN scheduling ground rules, these guidelines treat one of the interrelated services as the primary service and the other one(s) as secondary. The customer is not specifically required to adhere to these guidelines; however, adherence to these guidelines will help to ensure that use of the flexibility parameters will result in a scheduled event whose service structure is consistent with the customer's intent and that complies with SN scheduling ground rules.

4.2.1.1 Recommended Relationships

It is strongly recommended that the customer apply the service-level flexibility parameters to the primary and secondary services as follows:

- a. If the primary service has no flexibility (i.e., SBSN, CSN, STPT, STMT, and MIND are not used), the secondary service may or may not be linked to the primary with SBSN or CSN.
- b. If the primary service has flexibility (i.e., at least one of SBSN, CSN, STPT, STMT, or MIND is used), the secondary service should be linked to the primary service with either SBSN or CSN. This linkage will automatically preserve the required relationships between the services if the primary service is shifted. Although the NCCDS will always attempt to schedule a valid event, failure to specify this linkage significantly complicates the task and may preclude full use of the specified flexibility and/or result in inability to schedule a valid event.

4.2.2 One-Way Tracking

4.2.2.1 General Requirements

- a. A tracking service's service specification code (SSC) indicates one-way tracking when all of the following are true:
 - 1. Tracking configuration is normal.
 - 2. One-way Doppler tracking is required.
 - 3. Range tracking is not required.
 - 4. Time transfer is not required.

- b. A one-way tracking service must be associated with a return service. The tracking service's SSC indicates both the return service type and the return service's SSC. The return service cannot be a KaSAR service.
- c. The start time of the tracking service can be no earlier than the start time of the return service.
- d. The stop time of the tracking service can be no later than the end time of the return service.
- e. A return service can have only one tracking service associated with it at any one time.
- f. The nominal schedule request must specify a valid event.

4.2.2.2 Primary and Secondary Service Relationships

The return service is the primary service. The one-way tracking service is the secondary service. If any service-level flexibility is specified for the return service, it is strongly recommended that the tracking service be explicitly linked to the return service. The following discussion of NCCDS limitations assumes that this linkage is specified if service-level flexibility is specified for the return service.

4.2.2.3 NCCDS Limitations

The NCCDS must limit its use of the specified service-level flexibility parameters to ensure that the general requirements are satisfied. The primary requirement relevant to use of the service-level flexibility parameters is that the tracking service be bounded by the return service. The following specific limitations apply to one-way tracking. Additional limitations would apply if multiple one-way tracking services were to be specified for a single return service.

- a. Return service specifies MIND.

The NCCDS may use MIND to shorten the return service. This would be done to resolve return service resource conflicts. The NCCDS must limit its use of the return service MIND to ensure that the return service does not end before the end of the tracking service.

- b. Tracking service specifies STPT.

The NCCDS will not normally use STPT if it is specified on a one-way tracking service, i.e., sliding the tracking service to a later time will not normally help to avoid conflicts.

- c. Tracking service specifies STMT.

The NCCDS may use STMT to slide the tracking service to an earlier time. This would be done to offset use of return service MIND that could otherwise bring the return service stop time earlier than the tracking service stop time. The NCCDS must limit its use of tracking service STMT to ensure that the tracking service does not start before the return service.

- d. Tracking service specifies MIND.

The NCCDS may use MIND to shorten the tracking service. This would be done to offset use of return service MIND that could otherwise bring the return service stop time earlier than the tracking service stop time. There are no specific limitations on the extent of this use of MIND.

- e. Tracking service specifies SBSN.

The NCCDS will normally start the tracking service at the start time of the return service, i.e., sliding the tracking service to a later time will not normally help to avoid conflicts.

4.2.3 Coherent Pairs

4.2.3.1 General Requirements

- a. As specified by parameters in its SSC, a return service may be either coherent or non-coherent. These parameters are also respecifiable.
 - 1. MAR. Coherency is indicated by the Mode parameter.
 - 2. SMAR, Normal SSAR, and Normal KuSAR. Coherency is indicated by combination of Data Group, DG1 Mode, and DG2 Type parameters.
 - 3. KaSAR. Coherency is indicated by combination of Data Group and DG2 Type parameters; but these must always be set to DG2 non-coherent.
 - 4. Shuttle SSAR. Coherency is indicated by Shuttle Transmit Frequency (FRQ2) = 0000000000.
 - 5. Shuttle KuSAR. Always non-coherent.
- b. When a return service is specified as coherent, it must be paired with a forward service. The possible pairings depend on whether the return service's receiver configuration parameter is specified as Normal or Cross.
 - 1. Normal support coherent pairs:
 - KuSAR and KuSAF.
 - SSAR and SSAF.
 - MAR and MAF.
 - SMAR and SMAF.
 - 2. Cross support coherent pairs:
 - SSAR and MAF.
 - SSAR and SMAF.
 - MAR and SSAF.
 - SMAR and SSAF.
- c. The return service must start no earlier than the start time of the forward service, and no later than the end time of the forward service.

- d. The nominal schedule request must specify a valid event.
- e. When the NCCDS applies flexibility, it should ensure a minimum of one minute of forward and return overlap.

NOTE

This is an arbitrary rule not directly based on any SN scheduling ground rule. It is intended to preclude the scheduling of a coherent return service beginning very shortly before the end of the associated forward service.

4.2.3.2 Primary and Secondary Service Relationships

The forward service is the primary service. The return service is the secondary service. If any service-level flexibility is specified the forward service, it is strongly recommended that the return service be explicitly linked to the forward service. The following discussion of NCCDS limitations assumes that this linkage is specified if service-level flexibility is specified for the forward service.

4.2.3.3 NCCDS Limitations

The NCCDS must limit its use of the specified service-level flexibility parameters to ensure that the general requirements are satisfied. The primary requirements relevant to use of the service-level flexibility parameters are that the start time of the return service be bounded by the forward service, and that there be a minimum of one minute of forward and return overlap. The following specific limitations apply to coherent pairs:

- a. Forward service specifies MIND.

The NCCDS may use MIND to shorten the forward service. This would be done to resolve forward service resource conflicts. The NCCDS must limit its use of forward service MIND to ensure a minimum of one minute of overlap between the forward and the return service. If the return service specifies SBSN, the NCCDS must limit its use of forward service MIND to ensure that the forward service does not end before the end of the return service.

- b. Return service specifies STPT.

The NCCDS may use STPT to slide the return service to a later time. This would be done to resolve return service resource conflicts. The NCCDS must limit its use of return service STPT to ensure a minimum of one minute of overlap between the forward and the return service.

- c. Return service specifies STMT.

The NCCDS may use STMT to slide the return service to an earlier time. This would be done to resolve return service resource conflicts, or to offset use of forward service MIND that could otherwise place the end time of the forward service less than one minute after the return service start time. The NCCDS must limit its use of return service STMT to ensure that the return service does not start before the forward service.

- d. Return service specifies SBSN.

The NCCDS may use SBSN to slide the return service within the forward service. Unless a later start time is needed to resolve return service resource conflicts, the NCCDS will start the return service at the start time of the forward service.

- e. Return service specifies MIND.

The NCCDS may use MIND to shorten the return service. This would be done to resolve return service resource conflicts, or if SBSN were specified for the return service to offset use of forward service MIND that could otherwise place the end time of the forward service earlier than the end time of return service. There are no specific limitations on the extent of this use of MIND.

4.2.4 Two-Way Tracking

4.2.4.1 General Requirements

- a. A tracking service's SSC indicates two-way tracking when any of the following is true:
 - 1. Range tracking is required.
 - 2. Two-way Doppler tracking is required.
 - 3. Time transfer is required.
- b. A two-way tracking service must be associated with both a return service and with a forward service. The tracking service's SSC indicates the return service type, the return service's SSC, and the forward service's SSC.

NOTE

The valid pairs of forward and return services for two-way tracking are the same as the valid pairs for coherent support.

- c. The tracking service must lie within the intersection of the forward and return services.
- d. A return service can have only one tracking service associated with it at any one time.
- e. A forward service can have only one tracking service associated with it at any one time.
- f. For valid two-way tracking to be performed, the return service must be coherent with the forward. If the return service is initially specified as coherent, all of the above rules applicable to coherent pairs apply in addition to the two-way tracking rules. However, the return service may be initially specified as non-coherent and then reconfigured to be coherent. In such cases, the coherent pairs scheduling rules do not apply.
- g. When two-way tracking is scheduled, the value from the "Tracking Configuration" parameter in the tracking service's SSC is used in the return service in place of the value from the "Receiver Configuration" parameter from the return service's SSC. This ensures that these two parameters will be consistent in the SHO, and may reduce the number of return service SSCs that must be maintained.
- h. The nominal schedule request must specify a valid event.

4.2.4.2 Primary and Secondary Service Relationships

Either the forward or the return service may be the primary service. Either the return or the forward service may be the secondary service. In terms of the general guidelines described in 4.2.1, the tracking service relates to the secondary service as if the secondary service is a primary service and the tracking service is a secondary service. If any service-level flexibility is specified for the primary service, it is strongly recommended that the secondary service be explicitly linked to the primary service and that the tracking service be explicitly linked to the secondary service. If any service-level flexibility is specified for the secondary service, it is strongly recommended that the tracking service be explicitly linked to the secondary service. The following discussion of NCCDS limitations assumes that this linkage is specified if service-level flexibility is specified for the primary or secondary service.

NOTE

If the return service is initially specified as coherent, the forward service must be the primary service and the return service must be the secondary service.

4.2.4.3 NCCDS Limitations

The NCCDS must limit its use of the specified service-level flexibility parameters to ensure that the general requirements are satisfied. The primary requirement relevant to use of the service-level flexibility parameters is that the tracking service be bounded by the intersection of the forward and return services. The following specific limitations apply to two-way tracking. Additional limitations would apply if multiple two-way tracking services were to be specified for a single pair of forward and return services.

a. Primary service specifies MIND.

The NCCDS may use MIND to shorten the primary service. This would be done to resolve primary service resource conflicts. This could shrink the intersection of the forward and return services. The NCCDS must limit its use of the primary service MIND to ensure that the tracking service lies within the intersection of the forward and return services. If the secondary service specifies SBSN, the NCCDS must limit its use of primary service MIND to ensure that the primary service does not end before the end of the secondary service.

b. Secondary service specifies STPT.

The NCCDS may use STPT to slide the secondary service to a later time relative to the primary service. This would be done to resolve secondary service resource conflicts. This could shrink the intersection of the forward and return services. The NCCDS must limit its use of secondary service STPT to ensure that the tracking service lies within the intersection of the forward and return services.

c. Secondary service specifies STMT.

The NCCDS may use STMT to slide the secondary service to an earlier time relative to the primary service. This would be done to resolve secondary service resource conflicts, or to drag the tracking service to an earlier time thereby offsetting use of forward service MIND that could otherwise bring the end of the primary service earlier than the

end of the tracking service. Use of STMT on the secondary service could shrink the intersection of the forward and return services. The NCCDS must limit its use of secondary service STMT to ensure that the tracking service lies within the intersection of the forward and return services.

d. Secondary service specifies SBSN.

The NCCDS may use SBSN to slide the secondary service within the primary service. Unless a later start time is needed to resolve secondary service resource conflicts, the NCCDS will start the secondary service at the start time of the primary service.

e. Secondary service specifies MIND.

The NCCDS may use MIND to shorten the secondary service. This would be done to resolve secondary service resource conflicts, or if SBSN were specified for the secondary service to offset use of primary service MIND that could otherwise place the end time of the primary service earlier than the end time of secondary service. Use of secondary service MIND could shrink the intersection of the forward and return services. The NCCDS must limit its use of secondary service MIND to ensure that the tracking service lies within the intersection of the forward and return services.

f. Tracking service specifies STPT.

The NCCDS may use STPT to slide the tracking service to a later time relative to the secondary service. This would be done to offset use of STMT on the secondary service which could otherwise drag the start of the tracking service to be earlier than the start of the primary service. The NCCDS must limit its use of tracking service STPT to ensure that the tracking service ends no later than the end of the return service and no later than the end of the forward service.

g. Tracking service specifies STMT.

The NCCDS may use STMT to slide the tracking service to an earlier time relative to the secondary service. This would be done to offset the use of MIND on either the primary or secondary service which might otherwise bring the primary or the secondary service stop times earlier than the tracking service stop time. The NCCDS must limit its use of tracking service STMT to ensure that the tracking service begins no earlier than the start of the return service and no earlier than the start of the forward service.

h. Tracking service specifies SBSN.

The NCCDS will normally start the tracking service at the later of:

- Primary service start time.
- Secondary service start time.

Sliding the tracking service to a later time will not normally help to avoid conflicts.

i. Tracking service specifies MIND.

The NCCDS may use MIND to shorten the tracking service. This would be done to offset the use of MIND on either the primary or secondary service which might

otherwise bring the primary or the secondary service stop times earlier than the tracking service stop time. There are no specific limitations on the extent of this use of MIND.

4.3 End-to-End Test

4.3.1 General Requirements

- a. Within the schedule request, each forward end-to-end test service must immediately follow an associated normal forward service.
- b. Each forward end-to-end test service must be scheduled with the same start and stop times as the associated normal forward service.
- c. Within the schedule request, each return end-to-end test service must immediately follow an associated normal return service.
- d. Each return end-to-end test service must be scheduled with the same start and stop times as the associated normal return service.

4.3.2 Service-Level Parameter Guidelines

- a. The schedule request message formats require that the nominal service start time and nominal service duration parameters be specified for all services. However, the NCCDS will regard these parameters as being not applicable to end-to-end test services.
- b. None of the five service-level flexibility parameters should be specified for end-to-end test services. However, the NCCDS will disregard these parameters if they are specified for an end-to-end test service.
- c. It is strongly recommend that no service be linked to an end-to-end test service by use of CSN or SBSN. Any such linkage should be applied to the associated normal forward or normal return service.

4.3.3 NCCDS Scheduling

The NCCDS will schedule each end-to-end test service with the scheduled start and stop times of its associated normal forward or return service. Any service-level flexibility specified for the normal forward or return service is therefore automatically applied to the associated end-to-end test service.